assured by success in the examination than by investigation. This is no fault of his. It is the fault of those who having once grasped the fact hat ability of a certain kind can be tested, without any suspicion of unfairness, by marks assigned by examiners to candidates whose names they do not know, insist on applying this test, and this test alone, in as many cases as possible, without inquiry as to whether the ability of the examination-room is the kind of ability for which they are in search, or whether other evidence could not be obtained, sifted and allowed to weigh in the final decision. It is the fault of the public, which regards the mystic letters B.A. or B.Sc. as an infallible test of the merits of a schoolmaster, but would not have a notion of the meaning of the words if he were described as the author of a memoir in the *Transactions* of the Royal Society. Nowhere is a more strenuous condemnation of the defects of the examination system found than among scientific investigators who are also examiners in science. It is, of course, impossible to change suddenly a method to which the public assign a value far above that which it deserves; but if teachers of science suggest any mitigation of its severity, they are at once told that they are seeking to fill their class-rooms with candidates for their patronage, and that they are trying to evade the only satisfactory test of the value of their teaching. Under these conditions they are helpless. It is not they, but those whose motives cannot be misrepresented as self-seeking, whose opinions cannot be misrepresented as biassed, who can loosen the fetters which English public opinion binds around the intelligence of English youth, and, unfortunately, the majority of such persons are convinced that the present system is the best.

We have followed the precedent set by the *Times* in passing from the proposal for the establishment of a National Physical Laboratory to the discussion of the examination system, for we agree that the rejection of the scheme for carrying out research in the one, and the general acceptance of the other, are alike indicative of the present temper of the English people on such questions. They do not believe that scientific ability is worth the cost of training and using it. They refuse to supply laboratories for advanced students, such as German students possess. They make the advancement of a middle-class youth depend entirely on his success in examinations. As represented by the London County Council, they appear to think that the best use to which they can put a Huxley, when they are fortunate enough to secure his services, is to set him to lecture to evening students.

They refuse to admit that there are certain conditions which must be fulfilled if the tasks of giving advanced instruction in science, and of advancing science, are to be carried out successfully, and then they turn and rend those who, in spite of these difficulties, have done something to advance both education and learning. Truly, history repeats itself.

> "He said, Ye are idle, ye are idle. Go therefore now and work; for there shall no straw be given you, yet shall ye deliver the tale of bricks. And the children of Israel did see that they were in evil case."

PÖNTGEN RAYS AND CONSTITUTION OF GASES.

Röntgen Rays and Phenomena of the Anode and Kathode. By Edward P. Thompson, M.E., C.E.; with a concluding chapter by Prof. William A. Anthony. Pp. xiv + 190. (New York: Van Nostrand. London: Spon.)

The Constitution and Functions of Gases, the Nature of Radiance and the Law of Radiation. By Severinus J. Corrigan. Pp. viii + 127. (St. Paul: Pioneer Press Company, 1895.)

ALTHOUGH it is but a short time since Röntgen published his famous work on the X-rays, the very large number of scientific papers dealing with the subject, which have been published in all parts of the civilised world, makes the labour entailed in the production of a book of this kind very large.

Mr. Thompson, in his book on the X-rays, has endeavoured to give as complete an account as possible, not only of Röntgen's discovery, but of all the phenomena attending the passage of electrification through gases. With a view to make the subject intelligible to the lay mind, a short account is first given of induced currents and the discharge through gases at atmospheric and lower pressures. The author then passes to the consideration of the magnetic effects of the discharge, and the phenomena observed in the very high vacua of the Crookes' tube. A detailed description is given of Lenard's famous researches on the kathode rays, and of Röntgen's discovery of the X-rays and their properties. Considerable space is devoted to experiments dealing with the photographic developments and the use of the Röntgen rays in surgery. In the concluding chapter, Prof. Anthony sums up the results, and gives a short discussion on wave motion, without, however, venturing to suggest any explanation of the real nature and origin of the X-radiation.

A large number of X-ray photographs, or sciagraphs, as they are termed, are scattered throughout the volume, and some dust figures are also shown, a chapter being devoted to the description of them.

The author has adopted the method of dividing the book into numbered paragraphs, each of which is headed by the experiment to be explained, while references to the original publication are in nearly all cases given. The consequence of this is that the chapters consist of a detailed description of a number of experiments which are quite independent of one another; and as no attempt is made to criticise the results, or connect them together in any way, the result is somewhat confusing. The author, in many cases, lacks discrimination as to the relative importance which he assigns to the various experiments, and much of the earlier part of the book, notably the opening chapter, might be omitted with advantage.

The part of the book which deals with the X-rays, and the recent experiments on the subject, is much the best, and great praise is due to the author for the accurate *résumé* which has been given of nearly all recent work; and it is as a collected and condensed account of recent experimental work on the X-rays and allied phenomena that the book will be found most useful.

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In "The Constitution and Functions of Gases," by Severinus J. Corrigan, an attempt has been made to advance a new dynamical theory of gases, and to do away with the necessity of a continuous ether for the transmission of radiation through space.

In the ordinary kinetic theory of gases, which has been worked out so fully by Maxwell, Clausius, and others, the molecules of which the gas is composed are conceived to be in continual motion among one another, each molecule moving through a mean free path, while pressure on a surface is due to the continuous bombardment of the molecules. The theory which Mr. Corrigan advances is as strictly dynamical as the ordinarily accepted one, but is based on quite different assumptions. The molecule, instead of being in continual motion to and fro, is at rest, but is made up of a large number of atoms, which revolve in orbits, approximately circular, round the centre of the molecule with enormous velocities.

The atoms themselves are supposed to be "perfectly elastic, incompressible, spherical solids which are arranged primarily in duads or combinations of two, and the atoms of each duad combination are mutually attracted by a force in each atom, which force, like that of gravity, varies inversely as the square of the distance between the members of the duad." These two atoms are endowed with opposite polarity of some kind, probably magnetic, and are analogous to a system of binary stars of equal mass and volume, and their motion is governed by the laws of motion of celestial bodies. The molecule is supposed to be built up of an enormous number of these rapidly rotating magnetic couples with the planes of their orbits in all directions, so that the molecule is a hollow shell of gas, the surface atoms of which are in extremely rapid motion round the centre of the molecule.

The pressure of the gas is assumed to be proportional to the mass of the gas and the angular velocity or vibration frequency of the atom, while a change of pressure alters the diameter of the atomic orbit. In a very rare gas, therefore, the diameter of the atomic orbit is immensely greater than at ordinary atmospheric pressure.

Proceeding on these assumptions, the author certainly makes his theory satisfactorily account for some of the properties of gases. Great stress is laid on the theoretical deduction, from the hypothesis, of a law of radiation of identically the same form as the empirical formula of Dulong and Petit. The value of the constant is also deduced, and this is in complete agreement with the experimental value.

The ether, instead of being the continuous medium demanded by physicists, is supposed to be molecular and discontinuous—practically a gas of excessive tenuity. A large amount of space is devoted to the consideration of a mode of transmission of radiation, from molecule to molecule of the gaseous ether, with the velocity of light; but so many difficult assumptions are made in the course of it, that the explanation, though plausible, is not at all satisfactory. The impulse which the revolving atom receives from contact with a vibrating surface is supposed to be handed on from molecule to molecule with the velocity of light; but it is not clear why an atom of an adjacent molecule should always be in exactly the right position for the transmission of an impulse.

It will be of interest to mention a few of the results which the author deduces from his equations. The number of atoms in the atmospheric molecule is calculated to be about 10^{14}, and the orbital velocity of the atom of air at atmospheric pressure and temperature 500 million miles per second. The number of atoms per cubic centimetre of the gas agrees very nearly with the results deduced by Lord Kelvin and others. The density of the luminiferous ether (air = 1) is about $3 \cdot 10^{-16}$, and the diameter of a molecule of the ether ·002 inches.

As a consequence of the theory the conjugate atoms would be disrupted at an absolute temperature of 6679° Fahrenheit, and the author considers that disruptive electrical discharges, such as from an induction coil or in lightning, do break up the molecules, and it is the recombination of the dissociated atoms which causes the crash of thunder after the lightning flash.

The most unsatisfactory portion of the book is where the author endeavours to explain electrical phenomena, like atmospheric electricity, and natural disturbances, like tornadoes, by his theory of gases. A table of the dimensions and weights of the atoms of the molecules of the air and ether, which are deduced from the equations, is given; while a supplement is added to the book, deducing the same results in a different manner, and various theories are advanced in regard to the solar corona and astrophysics generally.

Though one may not agree with many of the author's assumptions, the fact remains that an interesting dynamical theory has been advanced which accounts for some phenomena not explained by any other theory; and for those who may be interested in speculations in regard to the nature and constitution of the gases and the ether, the book is well worth reading. E. R.

IMPRESSIONS OF OUT-DOOR NATURE.

A Year in the Fields. Selections from the writings of John Burroughs. With illustrations from photographs by Clifton Johnson. Pp. ix + 220. (London: Smith, Elder, and Co., 1896.)

A-Birding on a Bronco. By Florence A. Merriam. Illustrated. Pp. x + 226. (Boston and New York: Houghton, Mifflin, and Co., 1896.)

Summer Days for Winter Evenings. By J. H. Crawford, F.L.S. Illustrations by John Williamson. Pp. ix + 274. (London: John Macqueen, 1896.)

THE highest merit in any book of natural history is that it contains new and valuable information. Such books are often, but by no means inevitably, dry. Mr. A. R. Wallace may be named as one living writer who gives us new and valuable matter in a thoroughly readable form. Without being absolutely original, a book may yet be well worth writing if it contains a good deal of useful information served up in an attractive way. Then we come to the books which are attractive but not useful, and so to the books which are neither one nor the other.

None of the books before us belong to either the

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